ios

ABANDONED

143921

SERIAL NUMBER	FILING DATE	CLASS	SUBCLASS	GROUP ART UNIT	EXAMINER
07/143,921	01/14/88	~~364~~ 235	375	23~~1~~5	WEINHARDT

ARVIN D. DANIELSON, SOLON, IA; DENNIS A. DURBIN, CEDAR RAPIDS, IA.

WEINHARDT/~~235~~-235/380

CONTINUING DATA*******************
VERIFIED THIS APPLN IS A CIP OF 06/897,547 08/15/86, now ABN

FOREIGN/PCT APPLICATIONS**********
VERIFIED NONE

FOREIGN FILING LICENSE GRANTED 04/26/88

STATE OR COUNTRY	SHEETS DRWGS.	TOTAL CLAIMS	INDEP. CLAIMS	FILING FEE RECEIVED	ATTORNEY'S DOCKET NO.
IA	11	12	2	$ 450.00	5769-X

OLSON

CORE COMPUTER ... MODULE, AND PERIPHERAL SHELL MODULE MEANS FOR INCORPORATING ... TO FORM A POCKET SIZE DATA CAPTURE UNIT

This is to certify that annexed hereto is a true copy from the records of the United States Patent and Trademark Office of the application as originally filed which is identified above.

By authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

Certifying Officer

Date: APR 5 1995

Best Available Copy

[redacted]

ANDONED

MAY 19 2005

PATENT & TRADEMARK OFFICE

1/14/88

13921	PATENT DATE	PATENT NUMBER

UMBER	FILING DATE	CLASS	SUBCLASS	GROUP ART UNIT	EXAMINER
43,921	01/14/88	364	375	2315	WE

N D. DANIELSON, SOLON, IA; DENNIS A. DURBIN, CEDAR RAPIDS, IA.

NTINUING DATA**********************
IFIED THIS APPLN IS A CIP OF 06/897,547 08/15/86, now ABN

)REIGN/PCT APPLICATIONS************
IFIED

NONE

EIGN FILING LICENSE GRANTED 04/26/88

		AS FILED	STATE OR COUNTRY	SHEETS DRWGS.	TOTAL CLAIMS	INDEP. CLAIMS	FILING FEE RECEIVED	ATTORNEY'S DOCKET NO.
iority claimed ☐yes ☑no 9 conditions met ☐yes ☑no id Acknowledged	Examiner's Initials		IA	11	12	2	$ 450.00	5769-X

UMAN, WILLIAMS, ANDERSON & OLSON
WEST WASHINGTON STREET
ICAGO, IL 60602

RE COMPUTER PROCESSOR MODULE, AND PERIPHERAL SHELL MODULE MEANS FOR
ICORPORATING THE SAME TO FORM A POCKET SIZE DATA CAPTURE UNIT

This is to certify that annexed hereto is a true copy from the records of the United States Patent and Trademark Office of the application as originally filed which is identified above.

By authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

Certifying Officer

ate APR 5 1995

PATENT APPLICATION SERIAL NO. 143921

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

[redacted] [redacted]

PTO-1556
(5/87)

ABANDONED

143921

SERIAL NUMBER	FILING DATE	CLASS	SUBCLASS	GROUP ART UNIT	EXAMINER
07/143,921	01/14/88	~~364~~ 235	375	23~~1~~5	WEINHARDT

ARVIN D. DANIELSON, SOLON, IA; DENNIS A. DURBIN, CEDAR RAPIDS, IA.

WEINHARDT/235-235/380

CONTINUING DATA********************
VERIFIED THIS APPLN IS A CIP OF 06/897,547 08/15/86, NOW ABN

FOREIGN/PCT APPLICATIONS**********
VERIFIED
NONE

FOREIGN FILING LICENSE GRANTED 04/26/88

STATE OR COUNTRY	SHEETS DRWGS.	TOTAL CLAIMS	INDEP. CLAIMS	FILING FEE RECEIVED	ATTORNEY'S DOCKET NO.
IA	11	12	2	$ 450.00	5769-X

OLSON

CORE COMPUTER ... MODULE, AND PERIPHERAL SHELL MODULE MEANS FOR INCORPORATING ... TO FORM A POCKET SIZE DATA CAPTURE UNIT

This is to certify that annexed hereto
is a true copy from the records of the
United States Patent and Trademark Office
of the application as originally filed
which is identified above.

By authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

Certifying Officer

Date: APR 5 1995

11/22

3.7.90 - 13391

14 1988

Attorney Docket No. 5769-X

CERTIFICATE OF MAILING NO. B 50563181

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE DN 5769-X

APPLICATION FOR PATENT

531

TITLE: CORE COMPUTER PROCESSOR MODULE, AND PERIPHERAL SHELL MODULE MEANS FOR INCORPORATING THE SAME TO FORM A POCKET SIZE DATA CAPTURE UNIT

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a continuation-in-part of a copending application in the names of Dennis Alan Durbin, Raymond C. Lo, Gary A. Welsch and Stephen J. Kelly, entitled "Intelligent Information Card Terminal System", U.S. Serial No. 897,547 filed August 15, 1986 (Attorneys Docket No. 5769), now abandoned. Reference is made pursuant to 35 USC 120 to said copending application, and the entire disclosure thereof including the drawings is incorporated herein by reference.

New ABN

a

BACKGROUND OF THE INVENTION

This invention relates to shirt pocket size computer processor system means, and particularly to a plural module computer processor system capable of incorporating various data entry peripheral devices and of coupling with various data storage and data transmission devices while yet being suitable to be carried on the person of an individual user throughout a working day.

A long-standing problem in the hand-held computer field has been to provide a compact and efficient system for data capture while yet achieving low production cost. It is conceived

that a breakthrough can be realized by an optimum plural module system configuration.

In another aspect, the invention relates to novel terminal means for association with information cards and is particularly concerned with such terminal means for use by an individual user in communication with another computer system. There are many circumstances for example where an individual may desire to carry out transactions with a central computer processing station. In one example, a racing establishment such as a horse racing organization may desire to enable individual members having accounts with the organization to place bets from various locations such as home or office. In such a circumstance, it would be highly advantageous if the individual could communicate directly with a central computer system placing with the system all the information concerning a bet, and receive from the computer system essentially instantaneous information as to whether such a bet has been accepted. Another example relates to food service functions where orders may be transmitted to a central order processing center, and where credit or debit card purchases may be approved and/or related data stored at the central processor. Still another example is in the field of direct store delivery of merchandise. A pocket size terminal may contain the necessary information concerning the items being delivered and may be coupled with the store computer system to effect a paperless delivery transaction.

SUMMARY OF THE INVENTION

Accordingly it is an object of the present invention to provide a plural module system configuration that is adaptable to a wide range of data capture applications while retaining shirt pocket size and utilizing a core computer processor module of standard size and characteristics so as to achieve the economy of large scale production.

In a preferred embodiment the standardized computer processor module is provided with a multi-tasking operating system such that battery monitoring software and diagnostic routines will run at a fixed priority level at all times while a wide range of applications software can be run concurrently without jeopardizing the reliability of the system under extended portable operating conditions.

Preferably the standardized computer processor module is selectively associated with peripheral device shell configurations for adapting the system to specific applications. For example a shell configuration may include a scanner module for reading bar codes and a manual data entry and display means specifically tailored to a particular job such as package tracking, inventory, direct store delivery accounting, or the like. As a specific embodiment, the peripheral device shell may comprise a digitizer input tablet and display means which can receive handwritten input data and provide a desired confirming display. A conversational mode may provide for multiple interpretive displays of successively lesser probability in response to an input character or word which is ambiguous with

function key selection of the correct interpretation, or the like. A voice input and/or voice synthesizer shell module is another exemplary embodiment. Again in a conversational mode, the module may repeat input words in synthesized speech and/or provide a visual display thereof whereupon actuation of a function button or the like may instruct the module to present a second most probable selection from its vocabulary.

The handwritten or voice input modules may include a learning program for progressively improving recognition of the individual user's characteristic handwritten or voice input. Physical objects related to a given user application may be assigned respective code words e.g. of eight bits length; thus in the case of a food service function, in a food selection mode, the writing of the letter "P" with a stylus on an input tablet or the spoken word "potato chip" may be stored as the ASCII code for the character P in a special food selection storage. A nonvolatile storage section would enable the translation of the "P" code in food selection mode into the string of characters "potato chips" on the display and/or produce the synthesized speech output "potato chips". In a conversational mode, if there were two or more P items, the shell module could in response to a "P" input, present on the display a listing of the P selections, e.g., as P1, P2, P3, etc., whereupon the user could enter with a stylus or the like the correct numeral "1", "2", "3", etc.

According to an exemplary embodiment, a peripheral device shell may provide a transparent tablet serving as data input and as a display window. A sonic wave digitizer

arrangement for example may sense stylus (or finger) position on the tablet. The display may include a graphics liquid crystal display (LCD) behind the transparent tablet for defining a keyboard in a touch data entry mode, and for display of data supplied by touch entry, or by other means such as handwritten input, speech input, optical scanner input, and so on. Keyboard touch selection positions can be labeled by means of icons (pictorial images) where this is most effective. The shirt pocket size unit may be of sealed construction so as to be ideal for meter reading, timber inventory, or any environmentally demanding application.

The computer processor module may be employed with peripheral devices such as printers, laser bar code readers, RF modules, smart card interface modules, disk systems, full travel keyboards, high resolution displays, local area network (LAN) interface modules, etc., and various such devices may be combined in a single self-contained battery powered hand-held unit.

It is also an object of the present invention to provide a terminal means which can be utilized by an individual at various locations for direct communication with another computer system for the purpose of carrying out desired individual transactions.

It is another object of the present invention to provide such a terminal which can be conveniently carried on the person of an individual, for example, in a shirt pocket.

A further object of the invention is to provide a terminal unit which is adapted to incorporate a means for

reliably identifying an individual who uses the terminal and wherein the terminal facilitates each step in carrying out the desired transaction.

A feature of the invention resides in the provision of a terminal capable of removably receiving an information card with extensive memory capability and which, together with the terminal, can be held in one hand during entry of information concerning a transaction.

In accordance with a further feature, such a hand-held terminal system may incorporate means for two-way communication with a central computer system, e.g., via telephone lines or a radio frequency link.

In accordance with another feature, such a hand-held terminal system may be provided with a scanner for optically scanning visual information such as bar codes.

In accordance with another feature of the invention, such a hand-held terminal system may have dimensions of width and length comparable to a standard intelligent information card and of thickness to fit in the pocket, such as a shirt pocket.

In accordance with still another feature of the invention, such a terminal configuration is designed so as to be adaptable to a wide variety of applications without change in its basic housing configuration.

The foregoing objects will be more fully understood by reference to the following detailed description, and other and further objects, features and advantages will also be apparent from the present disclosure as a whole and from the individual

FIG. 7 is a diagrammatic perspective view of a shirt pocket size terminal means in accordance with the present invention, including a scanner tip, and having portions broken away to show internal components;

FIG. 8 is a diagrammatic cross sectional view for indicating internal components of the terminal means of FIG. 7;

FIG. 9 is a diagrammatic view of a core processor module with touch screen type display and having length and width comparable to a standard credit or debit card and thickness to fit in a shirt pocket;

FIG. 10 is a diagrammatic perspective view showing an exemplary shell configuration for readily receiving the core processor module of FIG. 9, to form a plural module terminal system, e.g., adapted for direct store delivery accounting;

FIG. 11 shows a store terminal device for coupling with the system of FIGS. 9 and 10;

FIG. 12 shows an exemplary coupling means for coupling the system of FIGS. 9 and 10 with the store terminal of FIG. 11;

FIGS. 13A and 13B are plots showing the variation of a bar code signal over the length of the bar code as generated for example when the illumination geometry is non-uniform, FIG. 13A being the case of black bars on a white background and FIG. 13B showing the signal variation for white bars on a black background;

FIGS. 14, 15, 16 and 17 are plots of bar code signal variation in the vicinity of a first bar, FIG. 14 showing a plot for a narrow first black bar on a white background, FIG. 15

showing the case of a narrow first white bar on a black background, FIG. 16 showing the variation for a wide first white bar, and FIG. 17 showing the case of black bars on a low contrast highly reflective white background; and

FIG. 18 is a flow diagram useful for explaining the processing of bar code signals such a shown in FIGS. 13A, 13B, and 14, 15, 16 and 17.

DETAILED DESCRIPTION

FIG. 1 is a perspective view illustrating a preferred terminal configuration 10 of a size to be held in the hand of the user. FIG. 1 illustrates the placing of an information card 11 into a receptacle 12 of the terminal. The card 11 may be a standard intelligent information card conforming with international standards such as the present ISO standard. Such a card may have the same length and width and thickness as a standard credit card now in use. By way of example, such a card

may have an array of eight contact terminals at one side thereof providing for interface with other devices. Such a card may have an electrically erasable programmable read only memory of a sufficient capacity to record an individual's account number, personal identification number and other information which may be desired for reliably identifying the individual. Further, such a memory may have a capacity for receiving extensive additional information such as might be required in effecting betting on a number of horse races.

By way of example, receptacle 12 may be provided with nub means 14 which is configured to cause the card 11 to flex at its edge 11a as it is pivoted into receptacle 12. Thus the nub means 14 may be spaced above the floor of the receptacle 12 by a distance slightly greater than the thickness of the card. An opposite side edge 11b of card 11 may be inserted under similar nub means at the opposite side of receptacle 12 and the card 11 then pivoted downwardly until edge 11a of the card is snapped under nub means 14. The nub means at opposite sides of receptacle 12 which cooperate with card edges 11a and 11b hold the card 11 in receptacle 12, and spring urged contacts in the floor of receptacle 12 make pressure engagement with the array of eight contacts on the underside of the card, once the card has been inserted.

Any suitable means may be employed to facilitate removal of a card from the receptacle 12. For example, a wall 15 of terminal 10 may be provided with a notch 16 enabling insertion of a fingernail or stylus under edge 11a of the card for prying the

card upwardly and out of the recess. The standard card 11 is sufficiently flexible so that this is readily accomplished.

In the embodiment of FIG. 1, a touch screen 17 occupies the side of the terminal opposite receptacle 12 and has an area generally comparable to the area of the standard card. By way of example, the touch screen may utilize LCD (liquid crystal display) technology and may be capable of displaying a number of lines of characters, for example four lines relating to four bets and additional lines which may, for example, provide an integrated graphic display (e.g., a single line of Chinese characters).

By way of example, associated with the touch screen at a surface 20 may be suitable indicia such as 21-24 for explaining the format of the display. In the specific illustration of FIG. 2, the characters "HV" may represent the initial letters of the name of a race track (e.g., Happy Valley), the next series of characters representing the data (e.g., year, month and day of month). Further characters on the display may relate to the day of the week, the type of bet or the like.

In the example of a transaction involving betting on a horse race, an exemplary keyboard display for touch screen 17 is indicated in FIG. 3. In an example where several race tracks may be involved, the identities of respective race tracks may be displayed at locations such as 31 and 32 in FIG. 3. Each location may display indicia indicating the programmed significance of the location. Simply by way of example, a prompt message at lines 33 and 34 might instruct the user to select the race track where the race to be the subject of a wager is to take

place. At the same time indicia representing the two race tracks would appear at 31 and 32. The user would then press location 31 or 32 with his finger to indicate the identity of the race track. A similar procedure could be followed for identifying the day of the race, the number of the particular horse on which the bet is being placed, the amount of the wager, and so on.

In the preferred embodiment of FIGS. 1 and 2, the terminal 10 is provided with an acoustic coupling means 50 which may serve to couple the terminal with telephone lines, for example. Thus in the case of betting transactions, once the user of the terminal has entered desired bets, for example on a number of horse races, the user may couple the terminal, e.g. via an acoustic coupler, with a handset of a conventional telephone, for establishing two-way telephone communication with a central computer system equipped to deal with the particular type of transaction and to authorize the individual participant. The touch screen 17 may display suitable prompt messages in establishing the telephone link with the central computer, or the processor of the terminal 10 may itself be programmed to establish the telephone link automatically, for example in response to actuation of a "SEND" location 35 of FIG. 3. Once communication is established, the processor of terminal 10 is able to transmit the data stored on the information card 11 via the telephone link to the central computer system so that the central computer system can verify that the individual is authorized to carry out the relevant transactions. In the case

of horse race betting, the information on the particular race and particular horses involved and the other details of the bet would be transmitted to the central computer system for verification and for evaluation of the total amount being bet, for example in relation to the individual's established account balance.

Also in the preferred embodiment as shown in FIG. 2, the housing is provided at a corner thereof with an optical scanner module 60 which may be utilized as a hand-held bar code scanner, and which also can serve for receiving optical communication via a suitable receiving device. In the case where the terminal utilizes rechargeable batteries, a receiving boot could automatically couple with a charging circuit for the battery means and this boot could also be provided with a host computer or suitable communication to a host computer system such that data from the intelligent card 11 and from the memory of the terminal itself could be communicated with the host system via an optical link including the scanner module 60, if desired.

Also as a preferred implementation, FIG. 4 illustrates a suitable processing system for the housing 10, including a microcontroller 70, a real-time clock 71, control and communication circuits 72, EPROM 73, random access memory components 74 and 75, a wand scanner and optical interface component 77, an acoustical coupler interface 78 and a module 80 for controlling character and/or graphic display of the touch keyboard screen for a particular desired application.

By way of example, intelligent information card 11 may be approximately 3-3/8 inches by 2-1/8 inches (about 9.5 centimeters by 5.4 centimeters). The dimensions of displays 17 and 117 are thus approximately comparable to the length and width of the card. (The card thickness is standard and about 1/32 inch). In FIGS. 1-4, the overall dimensions of the terminal 10 are not substantially greater than the corresponding card dimensions; the thickness is such that terminal 10 fits in an ordinary shirt pocket. By way of example, the terminal may have a thickness of less than one inch, i.e. less than 2.5 centimeters.

In the development of a preferred pocket-size terminal such as indicated in FIGS. 1 and 2, it is sometimes convenient to utilize a larger development terminal such as indicated at 100 in FIGS. 5A and 5B, which may utilize the same size of touch screen 117, (i.e. two inches by three inches), but may further utilize a highly versatile keyboard 120, and a much larger memory capacity so that many different features can be tried out for a particular application. At the rear of the touch screen 117, there may be a receptacle 125, FIG. 5B, for an intelligent information card exactly corresponding to receptacle 11 of FIG. 1. The terminal 100 is shown as being provided with an optical scanner module 130 which may function in the same manner as the module 60 of the preferred embodiment of FIGS. 1 and 2. In the example of FIGS. 5A and 5B, rechargeable batteries may be utilized, and a boot receiving the housing of terminal 100 may have provision for optical coupling with the computer system of the housing via an

optical output means 135. Optical communication from a host computer system may be via the optical scanner module 130 as in the embodiment of FIGS. 1-4. The housing of terminal 100 is provided with an acoustical coupling means for telephonic communication corresponding to the acoustical coupling means 50 of FIG. 1. An exemplary embodiment according to FIGS. 5A and 5B may utilize internal components as indicated in FIG. 6.

In the specific embodiment of FIG. 6, components 140-156 may have the functions and parameters as indicated by labels for the respective components in FIG. 6.

DESCRIPTION OF FIGS. 7 THROUGH 12

FIGS. 7, 8 and 9 show a shirt pocket size terminal configuration 200 generally corresponding to that of FIGS. 1-4, but omitting the card receptacle 12, terminal 200 includes the following components:

201 - casing
202 - membrane keyboard
204 - liquid crystal display
206 - display drivers
208 - batteries
210 - real time clock
212 - scanner module
214 - scanner tip
216 - plastic support for membrane keyboard 202 (FIG. 8)
218 - printed circuit board
220 - display/keyboard controller

222 - RAM

224 - microprocessor

226 - ROM - A/D

228 - real time clock, decode circuits

Referring to the graphics display of FIG. 9, data input into unit 200 may be by means of a touch screen display as indicated at region 230, or by means of a digitizer system for sensing the position of a manually held stylus.

Exemplary characteristics for such a unit are summarized as follows:

```
V25 CMOS MICROPROCESSOR      8 MHZ
          16 bit arithmetic logic unit
                8086 software compatible
          16K byte mask ROM
                retains VRTX operating system
                     diagnostic/power control routines
                     sophisticated loader

1 MEGABYTE ADDRESS RANGE
          2 UARTS -
                Full Duplex
                Internal Baud Rate Generators

RAM CMOS STATIC
          1 Megabyte- Less 16K ROM and 512 Internal RAM and SFR
          Holds Application Programs
          Also is Data Storage
          Battery Back-Up (Non-Volatile)

REAL TIME CLOCK/CALENDAR
          Provides Date/Time Information
          Back-Up

PLASTIC LCD DISPLAY
          64 X 128 Pixel Graphics Dot Matrix
          Built-In ASCII Character Generator
          Programmable Character Capability
          Limited Animation Capability

TRANSPARENT KEYPAD

          50 Keys in 5 x 10 Matrix
          Defined By Display For Location, Size, & Legend
```

BUILT-IN WAND TYPE SCANNER

User Input Capability In Addition To Keypad

RECHARGEABLE BATTERIES

Nicad or Lithium
Complete Control/Monitor Via Software
Offers Highly Reliable Remaining Battery Operating Time Gauge
Provides power to RAM + RTC Under All Conditions

I/O CONNECTOR

8 Pin
Programmable
Only Ground and Charge Pins Dedicated
5 Volt Interface
Never Powers Peripherals

ENVIRONMENTALLY SEALED

Plastic Case is Glued or Sonic Welded
Repair Procedure Is To Cut Case Away and Replace
Can Be Submerged

DISCUSSION OF FIGS. 7, 8 AND 9

The main attractions of a V25 micro-controller for the system of FIGS. 7, 8 and 9 are that it is CMOS, very high speed, and sixteen bits internal, with a nice collection of built-in peripherals. The fact it is 8086 software compatible means that VRTX (versatile real-time operating system) can easily be ported to the V25, with the addition of new I/O drivers. VRTX is a multi-tasking operating system, so the battery control circuitry software will run at a fixed priority level at all times as will diagnostic routines. Applications will be moved in and out as necessary.

The one megabyte of CMOS static RAM and the RTC are always supplied power. When battery voltage drops below a selected value, e.g., 4.5 volts, (the fuel gauge will read zero at this point) the unit shuts down and cannot be worked unless proper power is supplied to it on its charge pin. The unit will appear to shut down when not actively doing anything; however, touching the keypad will bring it to use. (Also I/O activity will wake it.)

The plastic LCD display is light in weight and relatively immune to mechanical injury. The graphics capability is advantageous so that the display can define the keypad, key location, size, and legend. It will display icons and provide vertical and horizontal movement. The display controller can work from a page larger than can be displayed and move around in the page without rewriting the display memory. The ability to

load-in custom character sets lets the unit perform I/O suitable to the country in which it is used (just by downloading new software).

The I/O may be strictly serial in operation; however, besides the two UARTS of the V25 there will be an 8530 SCC (serial communication chip) which will provide two more serial channels. This enables protocols to be run synchronously as well as asynchronously. The 8530 will provide bit, byte, and A-Sync communication at a high data rate- up to 1.5 megabytes per second.

Pursuant to an early concept of peripheral shells, the unit can stand alone in a package tracking, meter reading, tree counting or warehouse/store inventory environment, but possesses a great amount of power and with more peripherals could well become the next generation of low and mid-range terminals. A shell would be used to envelope the unit and house the external peripherals and additional power source they would require. A hand-held computer unit could be composed of a keyboard and a fifteen pin I/O interface with the whole under keyboard area filled with alkaline batteries to power the peripherals and the V25 core unit.

Similarly, a larger display, a printer, a permissive modem, an RF link module and other peripherals could be shelled around the core unit of FIGS. 7, 8 and 9.

By way of example, the terminal unit of FIGS. 7, 8 and 9 may have a width of the order of two inches (e.g. 2 1/8 inches),

a length of the order of three inches (e.g. 3 3/8 inches) and a thickness of the order of one inch (e.g. 3/4 inch).

In a digitizing input mode of operation of the unit of FIGS. 7, 8 and 9, successive character entry fields may be defined in a line across a screen area such as indicated at 240. For example, the rectangle 240-1 (presently containing the numeral "1") could receive a first character, e.g. manually entered as a series of strokes by means of a stylus. The unit could produce a graphical display in the form of lines corresponding to the paths of the successive strokes, e.g. at the line 242 above line 240. The program could analyze the input on the basis of the sequence in which the strokes were entered, rates of stylus movement, and so on, so as to interpret the intended character with substantial accuracy. The unit may display its interpretation of a manual character entry by displaying the corresponding stored character from its repertory at a line 244, e.g., as soon as there is a pause of selected (programmable) duration. If then the user begins drawing a new character, e.g., in a second field 240-2, the program will assume that its interpretation is correct and will automatically store it. If a given field is skipped, a space may be correspondingly automatically stored. The size of each character field and other parameters (such as pause duration) can be selected to have values convenient to the individual user, during a user set up mode, with suitable prompts from the display. The processor, during manual character entry, can be set to a learning mode where it seeks to adapt as accurately as possible to the writing

style of a given user. Such learning mode can be switched off whenever desired, as a further user set up mode parameter. A similar procedure could be followed for processor learning in the case of a speech input module.

FIG. 10 illustrates a shell module 260 having a receptacle 261 for receiving a processor core module such as 200, FIGS. 7, 8 and 9. Module 260 may cooperate with module 200 to provide a direct store delivery terminal. The terminal may have a card slot 262 for receiving a conventional smart card containing the information related to a delivery transaction, and may have an input/output coupler such as a one-fourth inch phone jack 264 for coupling with a store device 270, FIG. 11, via a connecting link such as 272, FIG. 12. Phone jack 264, FIG. 10, and phone jack 274, FIG. 11, may be one-fourth inch three-conductor phone jacks for receiving cooperating phone plugs 276, 277 of link 272.

The coupling between a smart card and a receiving terminal (such as 260, FIG. 10) is illustrated in the third figure at page 45 of an article entitled, "Smart Credit Cards: The Answer to Cashless Shopping" in IEEE Spectrum, February 1984 (pages 43-49) and this article is incorporated herein by reference by way of background. A similar coupling arrangement is preferred between modules 200 and 260.

By way of example the core module 200 may have an array of eight I/O contacts similar to those of the smart card of the third figure at page 45 of the IEEE Spectrum article just referred to. These contacts would mate with cooperating contacts

at a contact region such as indicated at 280 of module 260. Charge and ground contacts of module 200 could be of fixed function, while the other contacts could be programmable as serial channels, clocked data, analog inputs or outputs, or event inputs and outputs.

Module 260 may have a battery compartment 282 for receiving alkaline batteries for energizing suitable interface circuitry such as represented in the above-referenced third figure. A telephone jack may be located at 284 for coupling with the modem of the referenced third figure. Module 200 may couple with the interface circuitry of module 260 via contact region 280 in the same way as represented in the referenced third figure for the case of "Peripherals" and/or as represented for the case of a "Display", and "Keyboard", for example. A customer keypad may be coupled with module 260 in the same way as represented in the referenced third figure.

Typical shells for forming hand-held terminals with module 200 could be printers, laser bar code readers, RF modules, smart card interfaces (as at 262, FIG. 10), disk systems, full travel keyboards, larger displays, local area network interfaces, etc. A hand-held printer device which could serve as a shell for the processor module 200 is available commercially from Norand Corporation, Cedar Rapids, Iowa, and is referred to as a 40-column hand-held printer for use in product distribution systems, and is described in a brochure designated "960-182-0485" of Norand Data Systems.

DISCUSSION APPLICABLE TO ALL EMBODIMENTS

The concept of a plural module hand-held data processing system enables the use of a single computing engine to drive an entire product line. The basic or core module may comprise a self-contained limited input/output device with extreme reliability and flexibility. While the core module can serve many markets directly, many more can be met by using peripheral device shell modules which may integrate the core module into its confines. An internal fixed operating system protects the critical core module functions while allowing user applications to execute in a multi-tasking real time environment.

Of prime importance are the two requirements of low cost and tremendous capability. The lowest possible cost is achieved by use of technology yielding low manufacturing costs at high volumes. High volumes are achieved when a single product is flexible enough to perform well in multiple markets.

Of particular interest are flexible shirt pocket size plural module configurations which enable data input independently of a conventional keyboard. For example, a digitizer tablet input such as described with reference to FIGS. 7-12 is also applicable to the embodiments of FIGS. 1-6. Various optical type scanners are also of substantial utility for quick, easy and highly accurate input of existing printed data, e.g., bar codes, text, and graphical information. Instant type optical readers which may be integrated into a hand-held shell module according to the present invention are disclosed in a pending application of the present inventors U.S. Serial

No. 894,689 filed August 8, 1986, and the disclosure including the drawings of this pending application are incorporated herein by reference in their entirety as illustrating arrangements which may be embodied in a peripheral shell such as indicated at 260 in FIG. 10. For the embodiments of the copending application, the optical output means may be at opposite ends of battery compartment 282, while the reflected light optics and processing components may occupy the region below compartment 282 and a region replacing card slot 262, FIG. 10. The control and processing means of said copending application could be embodied in the basic core module such as represented a 200, or the display and manual data input means could be provided by a separate module in receptacle 261, while a basic processing module occupied a greatly reduced space such as represented at 300, FIG. 10, the processing module being inserted into a receiving well via a removable cover as is commonly the case with battery compartments such as 282. Such a cover could incorporate resilient means so that when the cover was latched, a core processing module at location 300 would have its eight metal contacts pressed against cooperating contacts of the receiving shell module such as 260. Referring to the article "Smart Cards" by Robert McIvor in Scientific American, November, 1985, at page 153, an eight contact terminal is shown in association with a single chip microprocessor system, from which it will be apparent that the width of the smart card could be reduced from fifty-four millimeters to twenty millimeters and fit edgewise into the region 300 (vertically as viewed in FIG. 10). For such a strip

type core module, the thickness could be substantially greater than the standard card thickness of .76 millimeters, for example ten millimeters.

The core module may incorporate the components of FIG. 4 or FIG. 6, or components such as 77, 78 and 80, FIG. 4, may be incorporated into a peripheral device module, for example one fitting into receptacle 261 of shell module 260, the core module incorporating the remaining components. Similarly as to FIG. 6, components such as 147, 148, 149, 150 and 151 can be incorporated into a module fitting into receptacle 261, while component such as 152 and 154 may be incorporated into the shell module 260, and the remaining components incorporated into the strip core module fitting into region 300.

Preferred features of an exemplary core module such as might fit into receptacle 12, FIG. 1, receptacle 125, FIG. 5B or region 300, FIG. 10, are as follows:

(1) User immune real-time multi-tasking operating system. The multi-tasking ability allows system programs of the core module to run in the background and never lose control. This ensures proper operation of the user's application(s) and system status availability.

A program known as VRTX (Versatile Real-Time Executive) and IOX (Input/Output Executive), available commercially, together with input/output drivers, monitors and control programs preferably compose the operating system stored in the core module (for example in read only memory ROM).

(2) A microcomputer compatible with personal computer architecture, e.g., an NEC V25 microcomputer with 8086 type architecture, supports the implementation of the operating system in that VRTX and IOX are 8086 oriented. A high integration CMOS construction directly supports the lower power standby and shut down features which are desired for the core module versatile interface adapter (VIA) software control. A one megabyte addressing range would be considered a minimum for hand-held units, along with a sixteen bit internal arithmetic logic unit.

(3) With a one megabyte memory, for example, read only memory necessary to contain the operating system would require about eighty kilobytes. All the rest of memory in the addressing range may be CMOS static random access memory used for applications.

(4) The core module preferably provides clock and calendar functions, and a hardware real time clock chip is compatible with very low power requirements.

(5) Battery operation is presently a key hardware aspect of a core module, and this is the main reason VRTX should provide immunity from the user. In order to offer unparalleled reliability in the field, the power control system should never be tampered with except under operating system control. The core module may use nickel cadmium rechargeable batteries. Such a core module preferably implements the intelligent battery system such as disclosed in U.S. Patents 4,455,523, 4,553,081 and in a pending application of Steven E. Koenck, et al., U.S. Serial

Number 876,194, filed June 19, 1986, now U.S. Patent Number 4,709,202. The intelligent battery system allows a very accurate "fuel gauge" for advising the user of remaining battery capacity. Fast charge capability offsets the lower capacity batteries which are preferably used in the core module. All of the RAM, the RTC and internal registers, e.g., of the V25 are battery backed up, even with the unit shut down.

Battery monitoring will also indicate possible problems before they become serious and, combined with other system monitoring, will provide unprecedented forewarning of possible impending failure. All devices will ultimately fail, but it is extremely advantageous if a unit can be removed from service before a hard failure occurs.

(6) The core module should be able to communicate with a host and with peripheral devices, for downloading of the application programs into the core module and for communicating with all types of input/output devices such as those referred to herein. Extensive flexibility in the communication protocol is provided for example by using two high speed serial channels capable of being programmed as asynchronous, byte synchronous or bit synchronous. Eight input/output contacts provide electrical connection to the outside. The charge and ground contacts may be fixed while the other contacts may be programmable as serial channels, clocked data channels, analog inputs or outputs, or event inputs and outputs. The concept of using peripheral shell modules for selective coupling with the core module offers complete expansion capability with minimal development time to

enter new markets. Typical shell modules could comprise graphics LCD display means providing a touch keyboard, digitizer tablet means, printers, laser bar code readers, RF modules, smart card interfaces, disk systems, full travel keyboards, larger displays, local area network interfaces, et cetera. Optionally, as illustrated in FIGS. 7, 8 and 9, for example, the core module may have a built-in minimal input/output capability such as may be achieved by using a graphics LCD display on one face of the core module for output and a touch responsive keyboard directly behind and defined by the display. The display, for example, may comprise 64 x 128 pixels, or eight lines by twenty-one characters, and may support any character set that can be defined. This is ideal for foreign applications. Since the keyboard is defined by the display, it will naturally be in the same language. The display (and keyboard) may be backlighted by a built-in electroluminescent panel. Many stand-alone applications for such a core module would require bar code scanning and thus a built-in scanner is illustrated at 212, 214, FIG. 7. Such a display would have the ability to use icons (pictorial images) as labels for keyboard locations, and to change them as the application requires.

A core module such as shown in FIGS. 7 and 8 could have a housing comprised of two die cast magnesium shells, glued together. Preferably there are no holes through the housing, so that the unit is submergible. It is ideal for meter reading, package tracking, timber inventory, or any environmentally demanding application. Internal construction is preferably of

one continuous flexible printed circuit board. This eliminates connectors, weight, and sources of failure. Preferably even the batteries are soldered in. The core module may withstand being dropped to a concrete surface from seven feet without functional damage. A minimum number of integrated circuits will reduce the cost and increase the reliability of the core module.

Where the graphics type keyboard displays icons representing physical objects, it will be apparent that such physical objects may be represented by a single code word such as utilized to represent any other keyboard entry. Such code may be translated into a corresponding graphical icon type display by means of a suitable read only memory or the like. A similar situation can prevail for example where shorthand characters are input to respective receiving regions such as indicated at 240-1 and 240-2 in FIG. 9. Spoken words related to a given application may likewise be represented by single code words in random access memory, and translated via read only memory or the like into corresponding strings of characters for display, or for synthesized speech output. As previously mentioned, if the letter P is related to a number of objects for a given user application, the user may input the letter "P" at a region such as 240-1 or 240-2, FIG. 9, whereupon the input strokes may be repeated at a corresponding location in row 242, and possible interpretations, either graphically, or as character strings, may be sequentially presented, e.g. at row 244. When the correct interpretation is displayed, the user may touch a suitable region of the display such as indicated at 310 to indicate approval of the current displayed interpretation.

In preferred hardware for implementing the illustrated embodiments, all memory and input/output accesses are allowed when the system is in the supervisor or system mode. On the other hand, any access by an application program to any area outside of its work and program areas (as assigned by the system) must immediately return control to the operating system for proper action. A microcomputer such as the V25 is advantageous because of its non-multiplexed bus, and built-in software-controlled power down. It would also be advantageous to have a built in hardware boundary checking of applications being run (as in the 80286). A digital semi-custom chip can accommodate this function externally.

A V25 internal timer may be used as the VRTX tick. Entrance to VRTX is through the NMI input of the V25. This is the only input (besides reset) that not only can wake the chip up if it's in a sleep mode, but also cannot be shut off by an application (thus disabling VRTX). Many sources may logically OR into NMI. The real-time clock, serial channels, charge indicator, and keyboard are some of these. Most of these should be programmable as to whether they can activate NMI.

The random access memory can be built as a separate module. For example eight 128 kilobyte chips and decoding may be in the module. A module select line should also be included since the module is expected to be useful in other product lines in multiple configurations. Standby currents of fifteen microamperes at two volts are being presently considered.

As real-time clock, an Intersil 7170 may be used since it is guaranteed to operate at two volts, the same as for RAM. The RTC and RAM are all battery backed up once low battery condition is entered.

For a shell module containing a display, a plastic LCD dot matrix display from Polaroid Corporation may be used. A display size of 64 x 128 pixels with eighteen mil pitch gives eight lines of twenty-one characters each (5X7 font). The controller may be the Epson E-1330. This is a graphics controller that can support three separate planes or pages for the screen and can combine them in many different ways. The planes can be graphic or characters. The characters can come from the internal ROM or RAM loaded by the application. A graphics plane could create boxes and a character plane could put legends in them. The E-1330 uses S-MOS 1180 and 1190 drivers to run the columns and rows (respectively) of the display. They apply a ten to fifteen volt bias on the display. This may be obtained from a plus five volt supply in the core module in combination with a variable minus twelve volt supply in the shell module and providing two to three milliamperes for the display. This supply is controlled by the E-1330 as for on-off but the V25 will be responsible for controlling the actually used voltage based on the temperature of the core module and user input information. A fast recovery crystal is preferred to minimize the time delay upon release of pressure (e.g. by the manual entry stylus or finger). Using a fast recovery plastic LCD display enables the user to press through the display and activate a

keyboard behind it. The display is used to define the keyboard or provide the "overlay". This gives the advantage of not only being able to continually change the keyboard as the application requires, but if the display is programmed in a foreign language such as Ethiopian, the keyboard is in the same language. Putting the keyboard behind the display allows for an opaque design of low contact resistance. The keyboard may be a 5 x 10 matrix (fifty keys) software configurable to be combined for any shape or icon style key defined by the display.

A soft (but tough) electroluminescent panel is preferred for backlighting, the keyboard being activated by pressing through the display and the electroluminescent panel. A tremendous advantage here is that not only is the display operable at night, but so is the keyboard (which is further programmable!)

A built-in wand scanner such as indicated in FIG. 7 preferably has a sapphire lens in a stainless steel or other hard metallic housing. Testing has shown that sapphire tipped wands will chip concrete before they break. It is preferable to make the chip very rugged rather than to make it easily replaceable. The wand housing is preferably clamped (and glued) right into a casing such as 201. The light source may be a near infrared visible LED to be able to read non-carbon inks and let the user know it is on, yet take advantage of the infrared capacity to read through many stains and smudges. Preferably the scanner is capable of reading in direct sunlight, and in this connection reference may be made to an application of Eric J. Danstrom, U.S.

now abandoned,

a= Serial Number 044,820 filed April 30, 1987, the disclosure including the drawings of which being incorporated herein by reference in its entirety.

An initial approach of a four N-cell nickel cadmium battery pack with each cell treated individually is now less preferred than a one cell "battery pack". The one cell pack requires a converter to boost the voltage. The single cell has many more advantages. No cell matching is required. No conditioning cycles are required, and it is not necessary to be concerned about cell voltage depression. A single converter to step up the voltage for a shell display module would be suitable, with a single switching regulator (current mode) to charge the cell from a much wider input range (e.g. from four to twenty volts). Fast charging on the order of 1C (or perhaps 2C) can be achieved since continuous monitoring of cell voltage and temperature curves (with respect to previous cell conditions) will allow proper charging with no risk of overcharge. This same monitoring applied to discharge as well, provides a very accurate "fuel gauge". Rechargeable lithium batteries may be considered, but the general recommended operating requirements do not match the preferred embodiment as described herein as well as nickel cadmium batteries. The charging line will have a diode blocking reverse current flow and inserted prior to the input/output terminal (for protection). This same single battery pack may also serve as the backup battery. The operating system may operate to equate ten percent or twenty percent of remaining

capacity in the battery pack to "zero" on the "fuel gauge" being displayed to the user.

In a preferred embodiment a surface type connector as used in smart cards has advantages in that it takes up very little space and cannot clog with dirt (can be wiped clean, e.g., during interconnecting of respective modules). Further, a surface type connector avoids the use of a cable. To maintain input/output protection and immunity from the environment, each core module may have all of its programmable input/output terminals disabled. The charge pin of a core module may be used to determine the presence of a peripheral shell. Each peripheral may have its own power supply and may or may not provide charge to the core. A peripheral module must at least provide a logic ONE (greater than one volt) to the charge pin in order to signal its presence. If such a logic ONE is present, the core module will determine if the peripheral module can charge it by enabling the charge regulator on the charge pin. If the level pulls low, it will indicate that the peripheral module is meant to only communicate with the core module but not charge it.

Preferably immediately inside of the case of a module will be an electrostatic discharge (ESD) resistor/diode clamp protection scheme. From there the I/O lines may go to a crosspoint type multiplexing circuit. Since in a preferred embodiment any of the six remaining pins can be inputs or outputs and connect to A/D channels in the module, voltage measurements could be made in a peripheral, e.g., by the core module and appropriate messages displayed to the user as to peripheral readiness and power levels.

The eight contacts of each module could be gold plated or the like such that they would be very conductive and yet tough. The contacts may be molded in a plastic insert that is glued into a hole at a location such as indicated at 280, FIG. 10, for example.

A case such as indicated at 201 in FIG. 7 can be in two pieces a front half and a back half, and the back half may have one rectangular flanged hole in which to glue the oppositely flanged I/O contact plate. The back half may be glued with conductive epoxy glue to the top case half. The top case half may have a large rectangular opening in which the display/electroluminescent panel/keyboard assembly fits. There may be a shelf behind this assembly for support with a glued-in bezel to seal the display and other components into the depression.

In an embodiment such as FIG. 7, preferably the mating corner portions of both halves may be specially molded to clamp around the scanner housing. When finally glued together, the resulting casing 201 may be completely sealed. It may be water and gas tight, but preferably not hermetically sealed where the display plastic is permeable. Purging the casing such as 201 with dry nitrogen at the time of assembly and sealing may increase reliability. Operation may be from somewhat below sea level (e.g. actually under water) up to 10,000 feet. The case such as 201 may have a size a little over three inches long by a little over two inches deep by about three-fourths inch thick, for example.

A module such as indicated in FIGS. 7, 8 and 9 would be suitable by itself for fields such as package tracking, price checking, inventory control, meter reading, consumer comparative shopping, et cetera. Various countries may require individually designed modules to couple with the module or module assembly of FIGS. 7, 8 and 9, in order to meet national requirements and the like, e.g, with respect to such peripheral devices as modems, power supplies and so on.

The core module previously referred to as being insertable into a space such as 300, FIG. 10, may also be insertable into a similar space in the module of FIGS. 7, 8 and 9, and may represent a standardized basic processing module having the real-time multi-tasking operating system and other characteristics previously described herein.

It will be apparent that many modifications and variations may be effected without departing from the scope of the teachings of the present disclosure. For example scanner tips such as indicated at 60, FIG. 2, or at 214, FIG. 7, may be adapted to left-handed users, by inverting the contents of the display. Thus if tip 214, FIG. 9, would be at the lower left with an upright display as shown in FIG. 9 for right-handed manual data entry, the module 200 might be turned by a left-handed user so that the tip 214 was at the upper right, and the contents of the display inverted.

Digital Signal Processing (FIGS. 13A, 13B and 14-18)

Reference is made pursuant to 35 U.S.C. Section 120 to Arvin D. Danielson and Dennis A. Durbin copending application for patent U.S. Serial No. 894,689 filed August 8, 1986, Attorneys Docket No. 5740, and the disclosure of the specification including the claims, and of the drawings of said copending application is hereby incorporated herein by reference.

A module such as shown in FIGS. 7, 8 and 9 may have a non-contact essentially instantaneous bar code scanner, e.g., at a long edge such as 311. Flash illumination where needed for the instantaneous bar code reader could be provided by a receiving shell such as shown in FIG. 10. The shell could contain the battery power for the flash illumination means in the shell and also for any LED marker light sources associate with the photodiode array of the processor module. A series of light emitting diodes could be used for each of the flash illumination sources of the second and third figures of the incorporated patent application Serial 894,689, and such LEDs could all be energized with simultaneous electric pulses, or the pulses could be supplied in quick succession to essentially simulate an instantaneous flash. Where the long edge 311, FIG. 7, contains the scanner window for receiving a reflected bar code image, the receptacle 261 could be shaped so that edge 311 would face frontally, and a frontal face such as 312, FIG. 10, but of a greater dimension would contain the flashable light source means, for example. The processor module and shell when assembled would be hand held in operation, and could be of overall size to fit in a shirt pocket.

The present invention is particularly concerned with improvements in instant bar code readers of the type shown in U.S. patents 4,282,425 and 4,570,057. The disclosures of these U.S. patents are incorporated herein by reference by way of background.

The instantaneous type of bar code reader with flashable illuminator means has proved to be extremely desirable for portable applications because of its unique simplicity and compact design. A significant goal of the present invention is to retain the major advantages of the present commercial instant bar code readers with flashable illuminator means while enhancing the capacity for reading bar codes of substantially greater length. An important related aspect of the invention is to enable the reading of such large labels by illuminating the same with an instantaneous flash of light while the labels are at a greater distance from the frontal end of the reader. A further development goal is to more effectively adapt the reading operation both to close up bar code labels of high reflectivity and to labels at greater distances and of curved configuration. It is also conceived that a major improvement is possible in the processing of bar code signals however generated.

In FIGS. 13A and 13B, the output level indicated at 321a, 321b may represent the output from the image sensor in the absence of light, while reference lines 322a, 322b and 323a, 323b, may represent the output level from the image sensor for the case of a black label of a specific uniform reflectivity and of a white label of a specific uniform reflectivity. The non-uniformity of the signal level over the length of a bar code is a result of the non-uniformity of the illumination of the bar code; and/or of the curvature of the bar code. The characteristics shown in FIGS. 13A and 13B apply generally to bar code reader systems where illumination is non-uniform or where the label is curved, and are not limited to flash illumination systems.

In accordance with the present embodiment, it is conceived that digital signal processing of a bar code signal before the normal decoding algorithms are applied can greatly increase the read rate and general readibility demonstrated by a scanner. By way of example, the output waveforms 325 and 326 of FIGS. 13A and 13B may represent the image sensor output of instant bar code readers such as shown in U.S. patents 4,282,425 and 4,570,057. As shown, the sensor output is smaller at both ends of a label than in the center. The main reason for this is the fall off of illumination at the ends according to the function $1/r^2$ where r is the radius from the effective point source at an end of the bar code. At the central portion of the bar code label, the corresponding function is $1/r$ due to an effective line source of illumination of the bar code at the center. This effect is multiplied when reading labels curved around cans and bottles where the label towards its ends is progressively farther away from the reader.

Both CKD pw

An image sensor has the advantage that it establishes an absolute dark signal as indicated at 331, FIG. 13A, and at 332, FIG. 13B, at the beginning of each reading operation. This allows the reader electronics the ability to always properly set up for detecting all bars and spaces of a label. A commercial instant bar code reader of the type shown in U.S. patents 4,282,425 and 4,570,057 uses this feature but incorporates a peak detector hardware circuit that digitizes the analog CCD output based on detecting peaks and comparing them with a fixed hysteresis to determine where a bar or space transition is located. This allows what is called first bar stretch

Both CKD im

if the hysteresis is too small and missed bars or spaces if the hysteresis is too large. The varying intensity pattern of the CCD output as illustrated in FIGS. 13A and 13B, when a single hysteresis value is used, contributes to ratiometric errors in the width counts of bars and spaces and makes it more difficult for the decoding algorithms to function in an optimum manner. The algorithms are designed to overcome only a fixed amount of variation. Most readers set up to detect a first black bar on white background as in FIG. 13A will miss the first bar for the case of a white bar on a black background as represented for example in FIG. 13B, while those set up to detect the first white bar for the case of FIG. 13B will tend to insert a bar when reading a label such as represented in FIG. 13A. Digital signal processing according to the present embodiment will result in proper detection of a first black bar on a white background as illustrated in FIG. 13A and will not insert bars or spaces in the case of either FIG. 13A or FIG. 13B.

By storing each sample in digital form until no longer needed, the successive pixels of the stored signal can be examined so as to greatly enhance the sensitivity and accuracy of the bar code reading process. In a preferred embodiment, the first pixels supplied by the CCD shift registers give absolute dark values such as indicated at 331 and 332. The corresponding stored pixel values provide a valid reference level from which to examine successive pixels of the bar code signal as digitally stored. As illustrated in FIGS. 13A and 13B, all bar codes will produce a negatively sloped signal in the vicinity of the first bar.

In one example of a signal processing procedure for processing the bar code signals resulting from scanning black bars on a white background and white bars on a black background, each signal is examined first to locate a slope reversal such as indicated at 341, FIG. 13A, or 342, FIG. 13B.

In a preferred embodiment, the criteria for a slope reversal is not only a change from negative slope to positive slope (or vice versa) but also a requirement that the changed slope extend for a specified amplitude range. This requirement is described as a need to meet a minimum "hysteresis level" once slope has changed (using a concept derived from the "hysteresis" effect where the output is made dependent on the direction of the input current traverse in certain electrical devices, e.g., in comparator type switching circuits where it is desired to avoid repeated cycling due to noise pulses). For example, in a preferred embodiment, a change from negative slope to positive slope in an initial part of a bar code, following a reference level such as indicated at 331, FIG. 13A, or 332, FIG. 13B, would require a signal amplitude increase as measured directly at the output A/D3 or A/D4 of the CCD array of sixty millivolts. Thus, if the amplitude increase from 341 to 351 in FIG. 13A is sixty millivolts or more, a first slope transition would be recognized at 341 for the purpose of further processing steps herein. Similarly, in FIG. 13B, the transition from 342 to 352 would need to have an amplitude of at least sixty

millivolts to have transition point 342 recognized as the first slope transition for purposes of the further processing steps. In examining the bar code signals for further slope transitions, as the signal increases in magnitude as the center of a bar code is approached, the required amplitude change or hysteresis value can be adjusted to correspondingly larger magnitudes to reduce the risk of error due to signal noise or label aberrations. The various hysteresis values can be software selected, and thus readily modified to adapt the processing to special labels or situations.

Once a first slope reversal is found as at 341, FIGS. 13A, or at 342, FIGS. 13B, the processor means may be programmed to examine succeeding pixels of the stored signal to locate a slope transition of opposite type, e.g., as indicated at 351, FIGS. 13A, or at 352, FIGS. 13B.

As previously explained, a slope transition is accepted for processing purposes if the signal level beyond the possible slope transition changes by a selectable hysteresis value. Where the peaks 351 and 352 meet this criterion, the signal between peaks 341 and 351, and between peaks 342 and 352 is examined to establish a suitable reference point for measuring bar width.

For the case of dark bars on a light label, the problem is better understood by reference to FIG. 14. If a first valid slope transition has a signal level A and a

second valid slope transition has a signal level B, the measurement of the width of the first dark bar should be taken from a transition point 360, FIG. 14, which is midway between the signal levels A and B,, i.e., at (A+B)/2. On the other hand for a following stored signal pattern between valid slope reversals at signal levels of B and C, a midpoint between levels B and C would not properly represent the reference point for measurement of the width of the first dark bar. The correct transition point is actually at a signal level of H. Thus, in order to identify the proper transition points for measurement of bar width, according to the procedure of the present invention, the maximum slope of the bar code signal between valid slope transitions is also taken into account.

In a preferred embodiment, a transition for purposes of measurement of bar width is taken as the maximum slope section of the signal closest to the midpoint between the signal levels of two successive valid slope reversals of opposite type. Utilizing this preferred criterion, the transitions in FIG. 14 for bar width measurement are (A+B)/2, H, (C+D)/2, (D+E)/2, (E+F)/2 and (F+G)/2.

Thus, in analyzing a stored signal pattern as represented in FIG. 14, the processor would proceed from the reference absolute dark level 331, and locate the slope transition from negative slope to positive slope at 341. The processor would then analyze the signal levels beyond point 341 to determine if the transition at 341 was to be regarded as a valid transition. For example, if the

differential between levels A and B corresponded to sixty millivolts of signal amplitude as measured directly from the output of the CCD array, the peak at 341 would be treated as a valid slope reversal for purposes of locating the measurement point 360.

In preparing signal data for processing, a filtering algorithm may be applied such that the stored and filtered data to be analyzed would plot as shown in FIGS. 13A, 13B and 14 without high frequency superimposed noise disturbances. In this case, the processor can simply identify peaks such as 341, 351 and 361 by their respective slope transitions and obtain the difference between levels B and C to determine if slope transitions 341 and 351 are to be considered valid. If the level B minus level A value does not meet the initial hysteresis criterion, then slope reversals 341 and 351 would be ignored, and slope transition 361 would be analyzed based on the required initial hysteresis value between levels C and D.

If the slope transition at 351 was such that the differential between levels C and B did not meet the hysteresis criterion, then slope transitions 351 and 361 would be ignored, and a further positive slope to negative slope transition, e.g., at 371 would be examined with respect to the required hysteresis criterion.

Once the first two bar width measurement points such as 360 and 370, FIG. 14, have been determined, the pixel count value between these measurement points is computed as a measure of the width of a first dark bar.

Such processing steps can proceed as background while further portions of the bar code signal are being read and converted to digital form.

When the predetermined number of pixels available from the photosensor 11, e.g., 5000 pixels, has been read into the processor, the read in process is complete, and processor 10 completes the bar code evaluation as promptly as possible.

Where a single processor program is to handle the analysis of both black bars on a white background and white bars on a black background, the program must analyze the signal region prior to the first valid negative to positive slope transition or first low peak for a knee such as indicated at 390, FIG. 13B. As indicated in FIG. 15, the width of the first white bar is then to be measured between points such as 391 and 392, FIG. 15. In other words, while the transition as at 360, FIG. 14, from a white space to a first black bar occurs after the first negative slope to positive slope transition, for the case of the transition from a black space to a first white bar, the transition occurs as shown at 391, FIG. 15, prior to the first negative slope to positive slope transition.

FIG. 16 is similar to FIG. 15 but illustrates the situation where the first white bar is much wider, and the black background to white bar transition occurs at a point such as indicated at 400 between a knee 401 and a first negative slope to positive slope transition at 402.

In order to examine the portion of a bar code signal prior to a first slope transition for a knee such as indicated at 390, FIGS. 13B and 15, or as indicated at 401, FIG. 16, the program analyzes the slope of the bar code signal at the beginning and working toward the first slope reversal.

First an initial slope is established based on the first few pixel measurements beyond the absolute dark reference portion (such as 331, FIG. 13A, or 332, FIG. 13B). Then the processor looks for an abrupt slope change in the negative direction relative to such initial slope of at least two to one. For example, if the initial slope was minus forty millivolts per pixel, then an abrupt change to at least minus eighty millivolts per pixel would be required to qualify as a valid knee prior to the first negative to positive slope transition. The slope value for comparison purposes is adjusted from the initial value after each determination of a gradual slope change so that gradual slope changes over a number of pixels will not cause a false indication of a knee transition. If no sufficiently abrupt transition in negative slope is found, it may be assumed that the first space to bar transition is located after the first negative slope to positive slope transition (as in FIG. 13A).

If a sufficiently abrupt change in negative slope is found, the program may treat such knee-like transition as a first slope transition, and then proceed the same as for the case of FIGS. 13A and 14.

By way of example, if the processor is to establish a list of valid slope transitions and has entered the pixel address of slope transition 342, FIG. 13B, as a first negative to positive slope transition, the processor may shift such pixel address to a location for a second slope transition, and enter the pixel address of transition 390, FIG. 13B, as the first slope transition. Having then established two valid slope transitions, the processor can subtract the respective signal level values from each other and divide by two to identify the level midpoint. If the processor has previously established a list of slope values for pixel addresses between points 390 and 342, the processor can examine the list to identify the maximum slope value. If several slope values close to the maximum slope are present, the processor selects the one closest to the level midpoint. For example, slope values within ten percent of the greatest slope value within an interval under consideration may all be considered as maxima for the purpose of selecting the maximum slope closest to the level midpoint, especially where individual pixel readings are subject to errors of this magnitude.

FIG. 17 illustrates the signal variation 410 for the case of black bars on a white background where the label is of low contrast and highly reflective. As indicated, a first low peak 411 may actually have a magnitude equal or greater than the second high peak 412, thus emphasizing the importance of controlling the processor to adaptively examine successive portions of the bar code signal as taught in reference to FIGS. 13A, 13B, 15 and 16. By controlling the processor to examine each transition with

respect to its own peaks and slopes, it is possible to validly decode a bar code signal which could not be otherwise analyzed.

As with all signals, there is noise to be accounted for, and the processor is controlled to maintain a minimum hysteresis for all values and to average multiple pixels for determining slopes. The number of pixels to be averaged and the minimum hysteresis to be used in the control of the processor can be software selected, and thus can be modified to adapt the processing to special labels or situations.

FIG. 18 illustrates an exemplary control program for the processing means 10 of FIG. 1 in implementing the analysis of bar code signals such as represented in FIGS. 13A and 13B which have been stored pixel by pixel in digital form. In digital signal processing mode, the processing means is controlled to read successive pixels so as to compute a slope value for a given pixel based on suitable average values. For the successive slope values as computed in step 421, the slopes are compared to identify a transition from a negative slope to positive slope as a "low peak". If such a transition is not found in step 422, decision step 423 is executed normally with a return to processing step 421 and the reading of a further pixel value and the computation of an associated average slope value. When a low peak such as 341, FIG. 14A, 342, FIG. 14B, or 402, FIG. 16, is located, the signal value associated with this low peak is stored as indicated by processing step 424. As represented by decision step 425, if this is the first low peak, then processing as indicated by step 426 takes place to examine the stored pixels

in the region between the absolute dark signal portion 331, FIG. 13A, or 332, FIG. 13B, and such first low peak. If a valid detected knee is found such as indicated at 390, FIGS. 13B and 15, or at 401, FIG. 16, then according to step 427, such valid detected knee is established as a first high peak value for the purpose of further processing as shown by step 428. Processing then proceeds according to step 430 with a computation of the first defined transition point such as indicated at 360, FIG. 13A, 391, FIG. 15, or 400, FIG. 16.

If decision step 427 failed to locate a "detected knee" before the first low peak, then the example of FIG. 13A would apply and processing would proceed directly to step 432. According to step 430, the pixel number associated with the transition 391 or 400 could be stored in a memory associated with processing means 10.

For the case of FIG. 13A, a high peak such as 351 would be identified by processing step 433 and the associated transition 360 would be determined by step 434, the processor storing the pixel number associated with the transition 360 in memory, and then proceeding to examine the stored signal according to processing step 421. A similar processing at steps 433 and 434 would detect the first high peak 352 and second defined transition 392, FIG. 15, and the first high peak 450 and second defined transition 451 for the case of FIG. 16. With the computation of the second transition in step 434, the processor would compute the bar code width as the difference between the pixel number of the second

defined transition 392 or 451 and the first defined transition 391 or 400, and store such difference as the width count for the first white bar.

In either event, processing would terminate as represented by decision block 423 or 453 after all of the pixels of the bar code signal had been examined.

It would be feasible to utilize the early decoding of initial bars of a bar code signal in order to speed up auto discrimination, e.g., the automatic decision by the processor as to whether a bar code is being read from a white or black background.

It will be apparent that many further modifications and variations may be effected without departing from the teachings and concepts of the present disclosure.

Supplementary Discussion Re FIGS. 7 through 12

The following gives examples pursuant to FIGS. 7 through 12 where the assembled plural module device has overall size so as to readily be carried in a shirt pocket when not in use.

Example I

In this Example I, the computerized processing module 200 of FIGS. 7, 8 and 9 has a width of 2 1/8 inches, a length of 3 3/8 inches and a maximum thickness of 3/4 inch. The scanner tip 214 may lie essentially within the foregoing dimensions as in FIG. 7.

The receptacle 261 of the peripheral shell module 260, FIG. 10, may have a uniform width so as to snugly receive the width dimension of the processing module 200 and a length dimension such that the module 200 is substantially contained within the receptacle 261 while the portion with scanner tip 214 projects a sufficient distance beyond edge 312 for convenient scanning of bar codes while it is assembled with the shell module 260. A ledge (not shown) may extend about the margin of the recess 261 so as to overlie a top margin of the casing 201 at regions such as 201a, 201b and 201c, FIG. 7, while leaving the region of membrane 202, FIG. 7, accessible to the user and leaving the display region of display 204 visible through the membrane 202 as in FIG. 9.

With such an arrangement the assembled parts 260 and 200 may have an overall length of five inches or less, and a uniform overall cross sectional perimeter of less than eight inches.

In this Example I, a smart card would be inserted lengthwise into a slot such as 262 which slot would have a width of about 2 1/8 inches, but such slot would be at the opposite side of the assembly from scanner tip 214 since the smart card would project a substantial distance from the assembly even when fully inserted into the slot, e.g. to a depth of two inches.

Example I may include all of the electrical and mechanical auxiliary means referred to herein with respect to FIGS. 7 through 12, and may include a smart card interface for reading and modifying transaction data stored on a smart card, and for effecting display of stored data from the smart card on the display of processor module 200, and for modifying data stored on the smart card according to data and instructions entered via the input/output means of processing module 200.

Example II

In this Example II, the computerized processing module 200 may have the same length and width dimensions as described for Example I, but may be inserted into recess 261 of the peripheral shell module 260 in a widthwise manner, the sides of recess 261 being separated by a uniform distance of about 3 3/8 inches, and such sides having longitudinal dimensions of less than 2 1/8 inches so that the long edge 311, FIG. 7, of the processing module 200 would be at the rear of recess 261 adjacent battery compartment 282, and the scanner tip 214 would project beyond frontal face 312, FIG. 10, for convenient contact with bar codes to be scanned.

In Example II, the smart card slot 262 would again accommodate a smart card width of about 2 1/8 inches, but the depth could be such as to receive the entire length of the smart card (if a suitable card ejection mechanism were provided).

With such an arrangement of parts and with such a modified peripheral shell configuration, location 300, FIG. 10, might be at the bottom of a shirt pocket and slot 262 at the top of the shirt pocket, with the overall length less than five inches. With the overall dimension of the assembled modules between scanner tip 214 and the external wall of battery compartment 282 being about 3 1/2 inches, the overall thickness could be about 1/2 inch, so that processing module 200 would be substantially thinner than 3/4 inch, for the case of a cross sectional perimeter of about eight inches (shirt pocket size). By way of example, a thin processing module 200 could receive its display and digitizer operating power from the shell module batteries at 282, FIG. 10.

Example II may include all of the electrical and mechanical auxiliary means referred to herein with respect to FIGS. 7 through 12, and may include a smart card interface as described for Example I as an auxiliary means of the processor module means for executing an auxiliary function, e.g., reading/writing with respect to a smart card in slot 262, FIG. 10.

<u>Example III</u>

For a configuration according to Example I or Example II, the display of FIG. 9 would still be visible with parts 200 and 260 assembled.

With the particular screen of FIG. 9 being displayed, touching any part of region 230 could place the system in touch screen data entry mode with a desired touch type keyboard or graphics display occupying the entire length of the display area over multiple lines, for example. Touching any part of the symbol 450, FIG. 9, on the other hand could place the entire display area in digitizer mode, e.g. using a digitizer stylus of suitable construction. For the digitizer example previously given with respect to FIG. 9, outlines of entry fields such as 240-1 and 240-2 of suitable size could extend across the entire display region; and lines of characters such as generated at 240, 242 and 244 would correspondingly be able to extend across the entire display area in digitizer data entry mode.

<u>Example IV</u>

The computerized processing module such as 200, FIGS. 7, 8 and 9, and such as 300, FIG. 10, for any of Examples I, II, or III may be of standardized construction, even where the shell module means have different configurations as in Examples I and II.

As previously described in detail, the computerized processing module 200 may be self-contained and may have a display screen occupying substantially an entire broad side of the unit, as is shown in FIG. 9. Input information, e.g. applied to a touch input region 230, FIG. 9, may be displayed over the surface of the display screen e.g. in five or more lines to the right of region 230. In the stylus input mode as depicted by the graphical symbol 450, FIG. 9, the unit registers the path of

movement of the manually held stylus e.g. at successive fields such as 240-1, 240-2, FIG. 9, along one or more lines e.g. as at 240, FIG. 9, extending substantially completely across the screen and of length comparable to the maximum length of the unit.

Examples I through IV

The computerized processing module 200 in each example provides highly versatile and compact input/output means adaptable to graphical display of any desired patterns, facilitating utilization of the standardized module for different applications, and on the basis of the languages or graphical symbols required for marketing of the unit in any desired locality worldwide.

The term "pocket size" as used herein refers to a device with overall dimensions so as to be carried in a shirt pocket. A shirt pocket is here taken as having a size of about four inches wide by five inches high; thus a device of overall size to readily fit in a shirt pocket would have a maximum cross sectional perimeter of about two shirt pocket widths (2 x 4 inches) or about eight inches. A device with maximum height of about five inches would fit inside a shirt pocket while a height of about seven inches might be carried safely in a shirt pocket.

Example V

As Example V, any of the embodiments of the foregoing Examples may utilize a digitizer screen, e.g., operating on a sonic principle with a sound transmitter located in the stylus and two receivers located some distance apart along each screen axis such that the differences in the x and y coordinates can be

calculated. To digitize successive points, the stylus can be activated automatically to transmit sound pulses at time intervals such that the set of position readings for each point is readily segregated and processed, and desired resolution is obtained.

The digitizer screen may be part of a peripheral shell such as 260, FIG. 10, e.g., fitting in a receiving recess 261 and retained by any suitable means, or the digitizer screen may be provided by membrane 202 itself, FIGS. 7, 8 and 9, and thus be part of a standardized computerized processing module.

In each case, the digitizer screen preferably occupies substantially the entire area of a broad side of the shell module such as 260 or of the standard processor module such as 200. The digitizer screen preferably has a size such as two inches by three inches when part of a processor module, but may have a size of e.g. approaching four inches by six inches for the case of a shirt pocket size shell module with a standardized processor module such as indicated at 300, FIG. 10.

Example VI

This example may correspond with Example V but the digitizer may operate on an optical principle such as described in U.S. Patent 3,764,813 wherein a passive stylus may be utilized.

Again, the digitizer screen may be part of a peripheral shell device such as 260, FIG. 10, or may be formed by membrane 202, FIG. 7, 8 and 9 of a standardized computerized processing

module. The dimensions of the digitizer screen may be as in Example V.

It will be apparent that many further modifications and variations may be effected without departing from the teachings and concepts of the present disclosure.

WE CLAIM AS OUR INVENTION:

1. In a hand-held data processing system,

computerized processing module means for computerized processing of data,

shell module means having auxiliary means for executing an auxiliary function, and having a receptacle for receiving said computerized processing means so that the computerized processing module means is substantially contained within said shell module means, and

coupling means providing communication between said shell module means and a computerized processing means in said receptacle,

said shell module means with said computerized processing module means assembled in its receptacle having an overall size so as to be readily contained in a shirt pocket.

2. In a hand-held data processing system according to claim 1, said computerized processing module means having a touch responsive input means for receiving input information in response to manual operations.

3. In a hand-held data processing system according to claim 1, said shell module means having means accommodating insertion of a smart card therein for coupling with the computerized processing module means.

4. In a hand-held data processing system according to claim 3, said computerized processing module means

<.BD8>

having display means for displaying information received from said smart card.

5. In a hand-held data processing system according to claim 1, said computerized processing module means together with said peripheral shell module means selectively providing a touch screen display and a stylus operated digitizing input at a common display region.

6. In a hand-held data processing system according to claim 1, said computerized processing module means having means operable for carrying out an optical reading function while entirely separate from said shell module means.

7. In a hand-held data processing system according to claim 1, said computerized processing module means having touch screen display means operable for presenting a graphical display and for receiving and storing manual input data while ~~entirely~~ separate from said shell module means.

8. In a hand-held data processing system according to claim 1, said computerized processing module means having input screen means for registering the path of movement of a stylus thereon so as to receive manually entered information while entirely separate from said shell module means.

9. In a hand-held data processing system, a self-contained computerized processing

module for computerized processing of data,

said processing module having graphical display means with a display screen occupying substantially an entire broad side of the module, and

means comprising said display screen for displaying information over substantially the entire surface of the display screen,

said self-contained computerized processing module having a size so as to be carried in a shirt pocket.

10. In a hand-held data processing system according to claim 9, said processing module having optical reader means for effecting the input of optical information.

11. In a hand-held data processing system according to claim 10, said graphical display means being coupled with said optical reader means for displaying information read by said optical reader means.

12. In a hand-held data processing system according to claim 9, means comprising said display screen for registering the path of movement of a stylus over the surface of the display screen so as to receive manually generated information.

<.BD8>

ABSTRACT OF THE DISCLOSURE

A hand-held processing system wherein a peripheral module may receive therein a computer processor basic module of standardized construction, with a user-immune real-time multi-tasking operating system. Advantageously the peripheral module or computer processor module may include a touch screen or other highly versatile and compact data input/output device adaptable to graphical and/or other input/output modes suitable for different applications, languages and the like.

143921

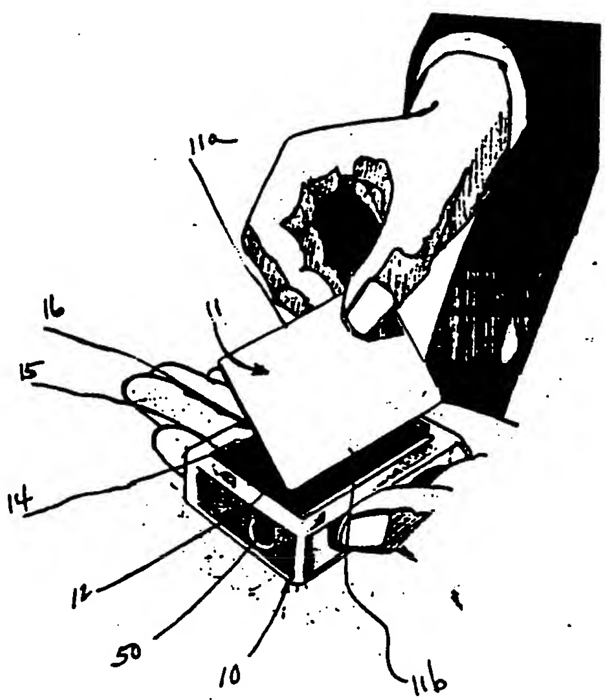


Fig 1

... Drawing
As Original Filed
Sheet 2 of 11
Express Mail
Receipt No. B 50563181

143921

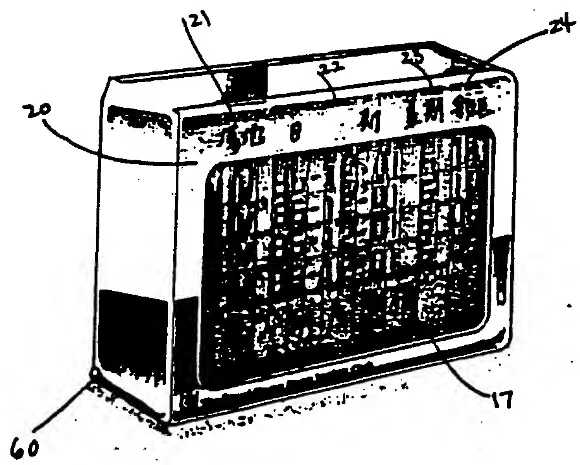


FIG. 2

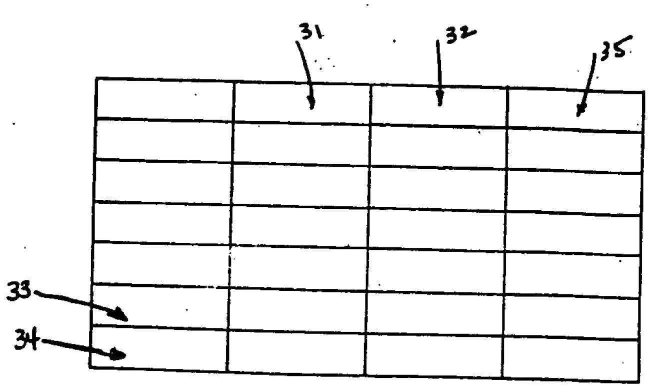


FIG. 3

Drawing
As Original Filed
Sheet 5 of 11
Express Mail
Receipt No. B50563181

143921

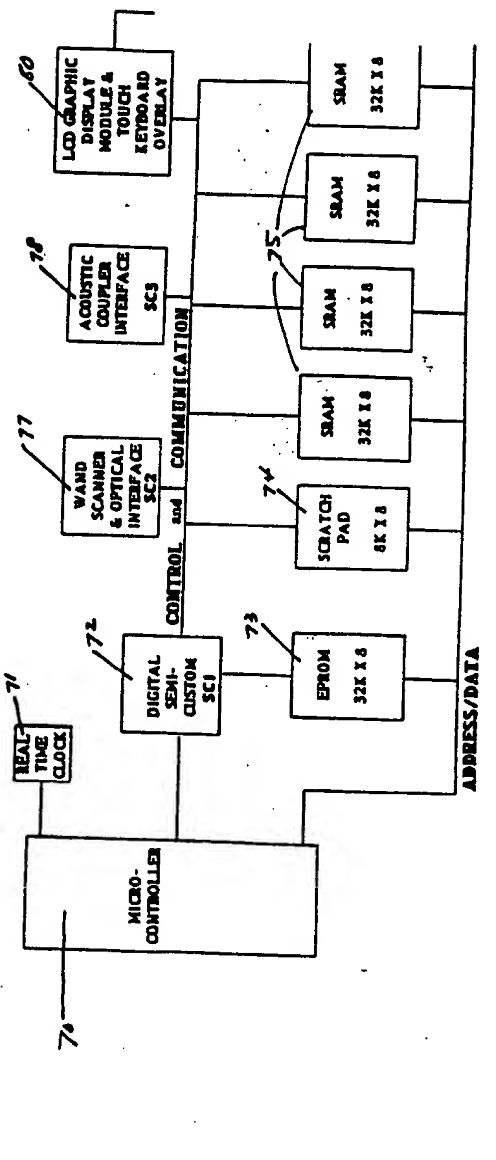


Fig 4

As Original Filed
Sheet 7 OF 11
Express Mail
Receipt No. B 50563181

143921

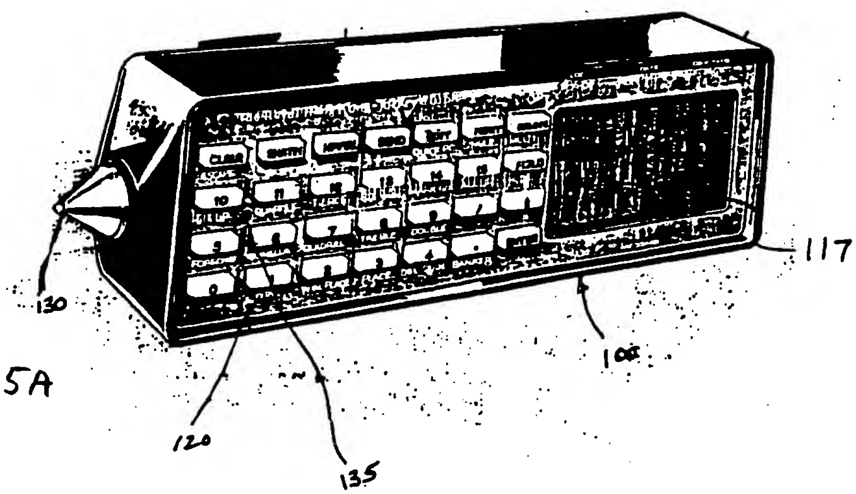
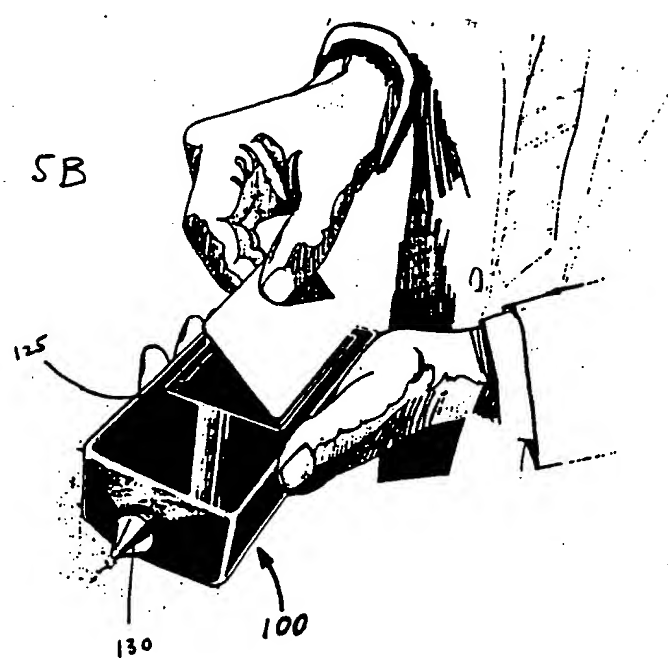


FIG. 5A

FIG. 5B



Sheet of Drawing
As Original Filed
Sheet 5 of 11
Express Mail
Receipt No. B 50563181

143921

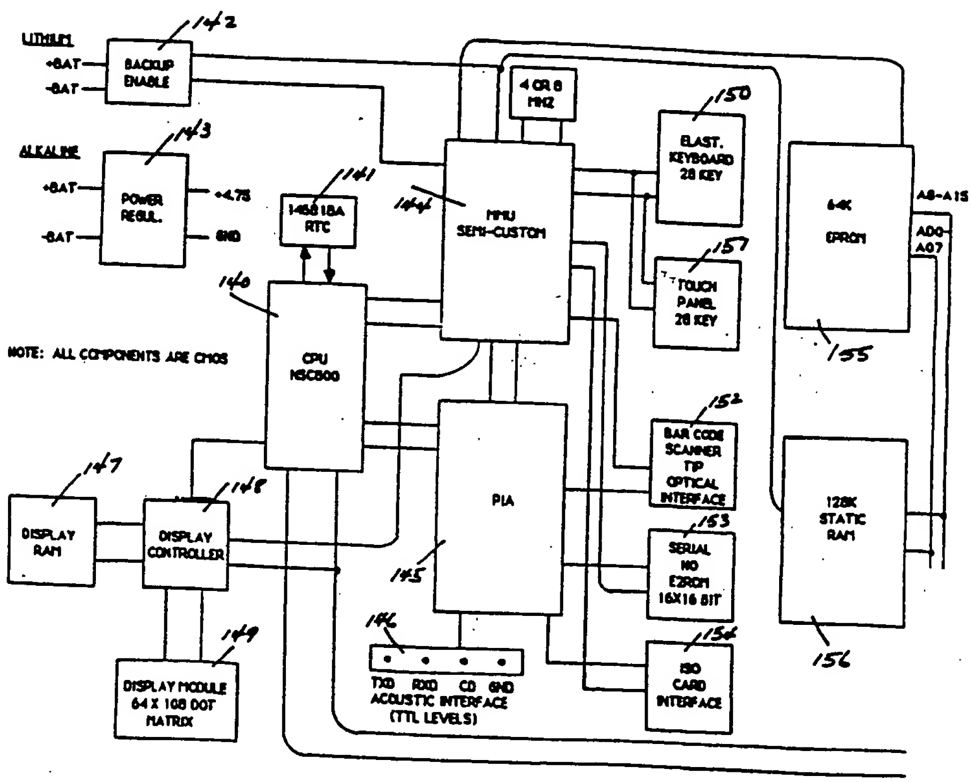


FIG. 6

Drawing
As Original Filed
Sheet ___ of 11
Express Mail
Receipt No. B 50563181

143921

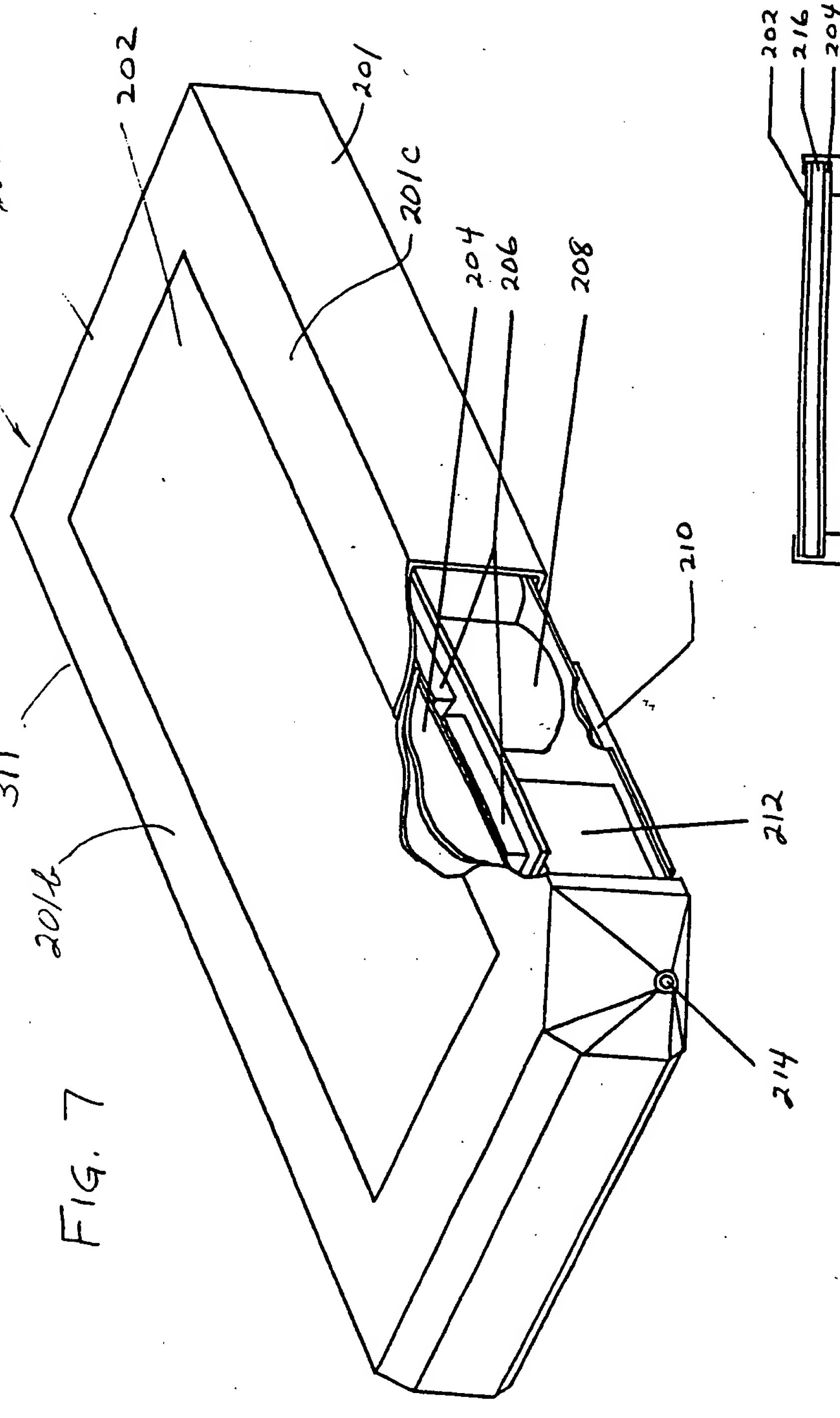


FIG. 7

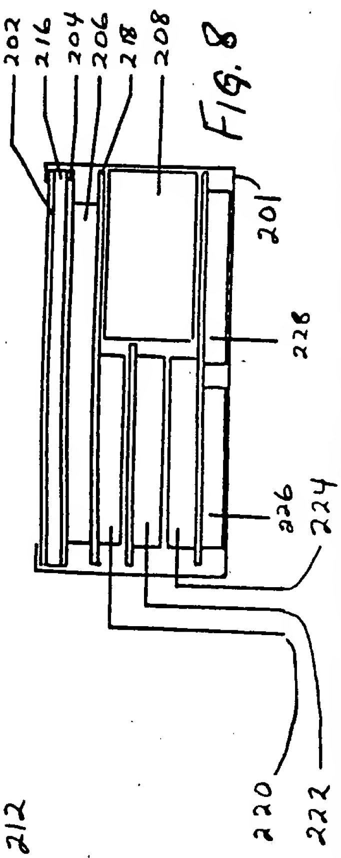


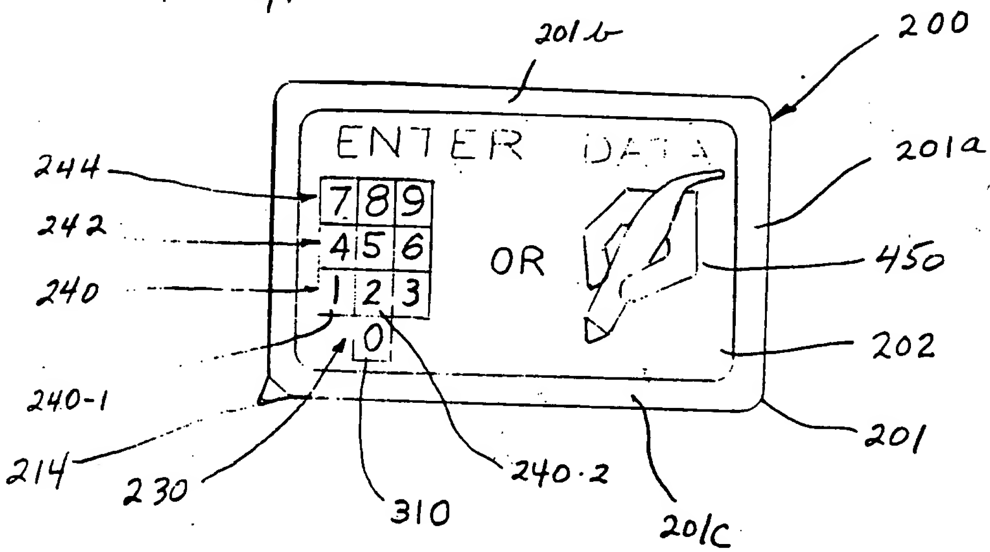
FIG. 8

As Original Filed

Express Mail
Receipt No. B 50563181

143921

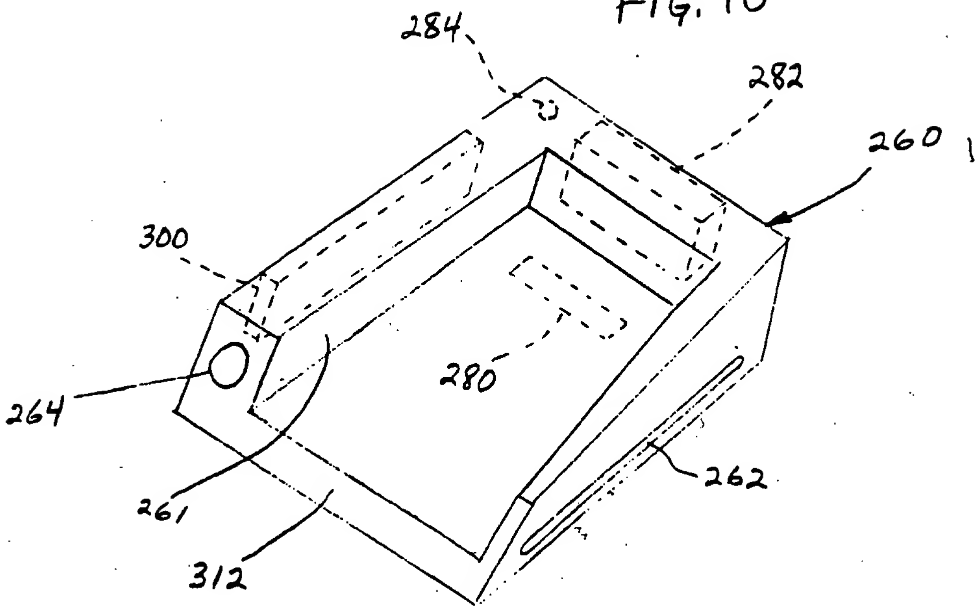
FIG. 9



As Original Filed

Express Mail
Receipt No. B 50563181

FIG. 10



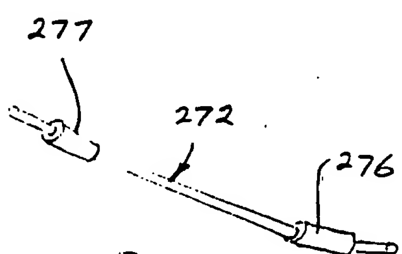


FIG. 12

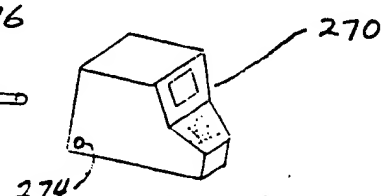


FIG. 11

... Drawing
As Original Filed

Sheet 4 of 11
Express Mail
Receipt No. B 50563181

143921

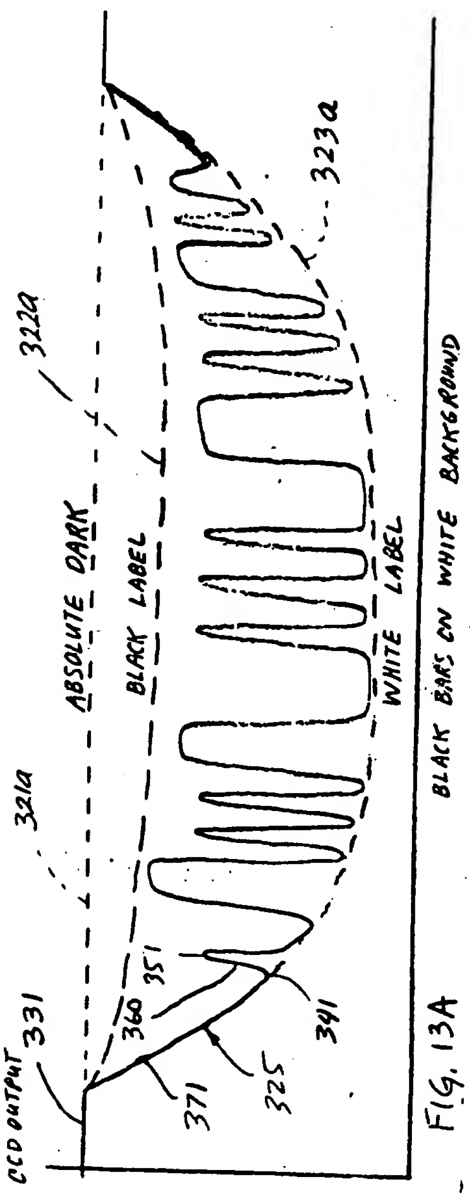


FIG. 13A

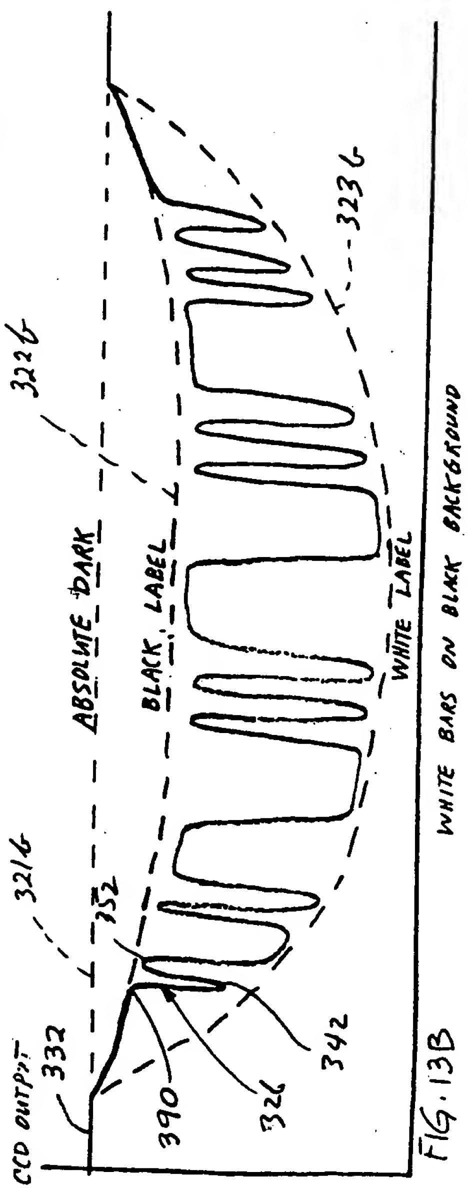


FIG. 13B

Drawing
As Original Filed

Express Mail
Receipt No. B 50563181

143921

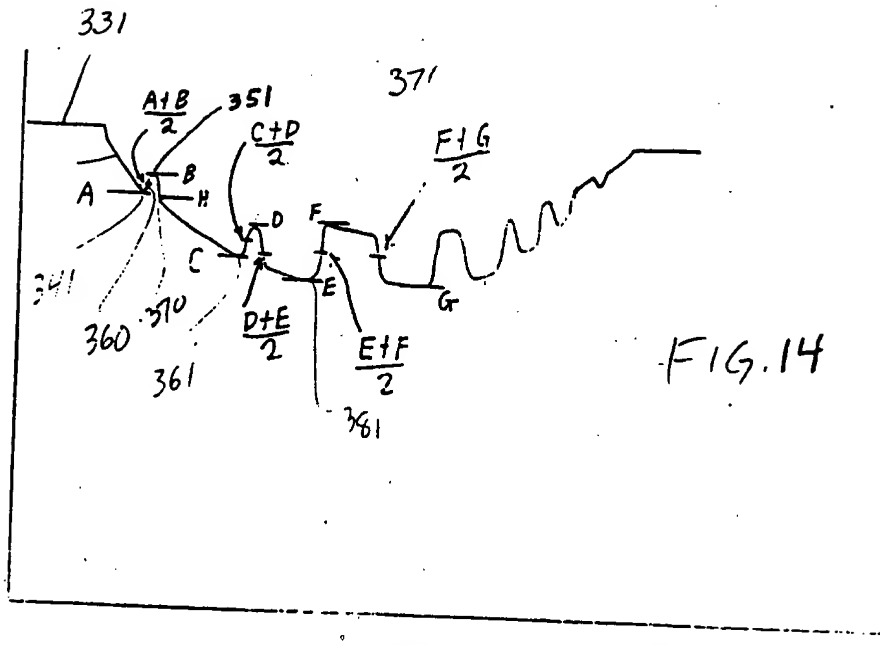


FIG.14

Fig. 15

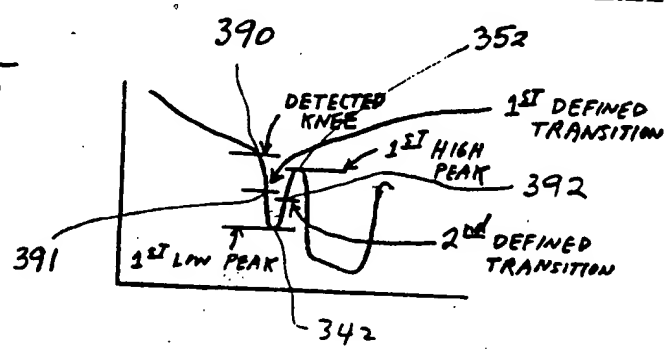


Fig. 16

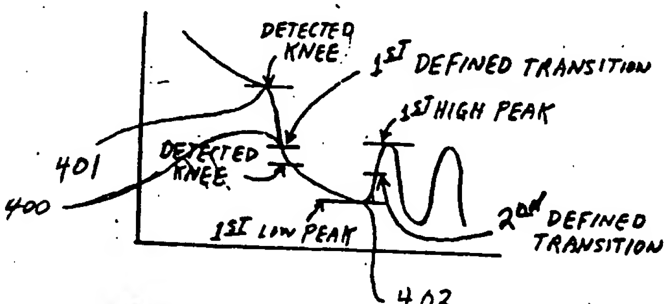
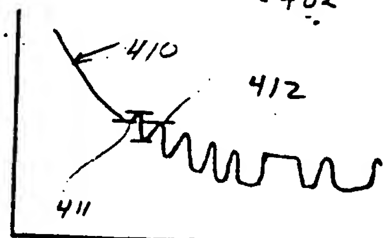


Fig. 17



Sheet of Drawing As Original Filed
Sheet 11 of 11
Express Mail
Receipt No. B 50563181

143921

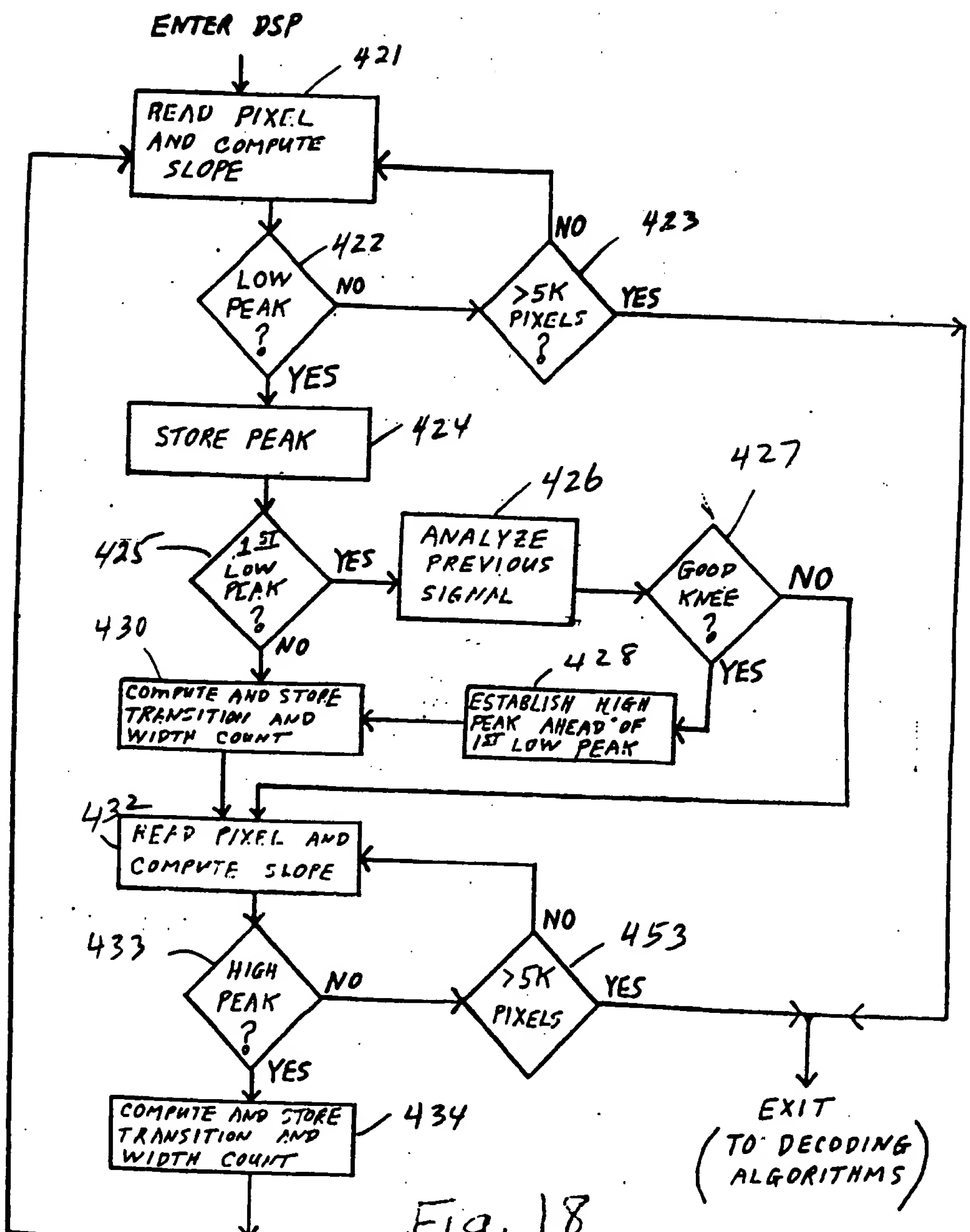


Fig. 18